# The Charcoal Iron Industry in the East Midlands, 1580-1780

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## I

Our understanding of the British iron industry in the three centuries between the introduction of the blast furnace and the end of charcoal-fired smelting has changed substantially since H.R. Schubert provided the first modern account.[1] In particular, the final phase, roughly 1660-1750, is no longer seen as one of decline, in which a growing shortage of fuel led to falling output, but a period in which production reached a higher level than ever before.[2] At no time between the sixteenth century and the eighteenth did the industry suffer an overall shortage of fuel and the domination of the home market by imports must be explained in other ways.[3] Similarly, the lengthy delay in the general adoption of coke-fired smelting no longer seems as mysterious as it once did.[4] On the other hand, there remains scope for a reassessment of the regional history of the industry, since most local studies were done before the national picture was so radically revised. This is especially true of the eighteenth century. Because earlier writers were so sure that ironsmelting was in decline up to 1750, and tended to ignore the charcoal-fired industry after that date, there is still scope to look afresh at the transition to coke-fired smelting in each region, in the hope of clarifying the details of this major technological change. As G.F. Hammersley asked of the charcoal iron industry some years ago: 'Did it fall or was it pushed'.[5]

This article attempts such a re-examination for the East Midlands, an area which admittedly lacks precise boundaries. Whereas since about 1800 ironmaking has been concentrated in a small number of well-defined regions, before then the industry was more widely dispersed. Although during the first two generations of blast furnace production both furnaces and forges were built close to sources of ore, after 1660, while furnaces generally remained near the ore, forges and mills tended to migrate from centres of production towards centres of consumption. Thanks to the work many years ago of B.L.C. Johnson, much is known of the extensive inter-regional trade in pig and bar iron in the century after the Restoration, in which the comparatively small East Midland industry, located between two major centres of consumption, the Birmingham region and the district around Sheffield, played a full part.[6] With this reservation, the local industry may be defined as that which smelted the easily accessible ironstone found in the coal measures of east Derbyshire, a coalfield which extends north into south Yorkshire, where another medium-sized iron industry existed in the early modern period.[7] To the south lies the district on the borders of Leicestershire where limited attempts were made to smelt the ironstone around Ashby-de-la-Zouch; this has been included here, even though it had no close connection with the main coalfield. Most ironsmelting in the East Midlands before the end of the eighteenth century was concentrated in the Rother valley of north-east Derbyshire, the district centred on Chesterfield. Although the furnaces were mostly in Derbyshire, the forges and mills were more widely scattered and included several in Nottinghamshire. Those in south Derbyshire were only a few miles from the nearest Staffordshire ironworks around Burton-on-Trent, with which they shared a common market in the Birmingham area and with which they were linked after 1712 by the navigable upper Trent.[8] The Burton works have not been considered here, if only because one has to draw boundaries somewhere, but this point illustrates the problem of regional definition in the dispersed but closely integrated industry in the late seventeenth and eighteenth centuries.

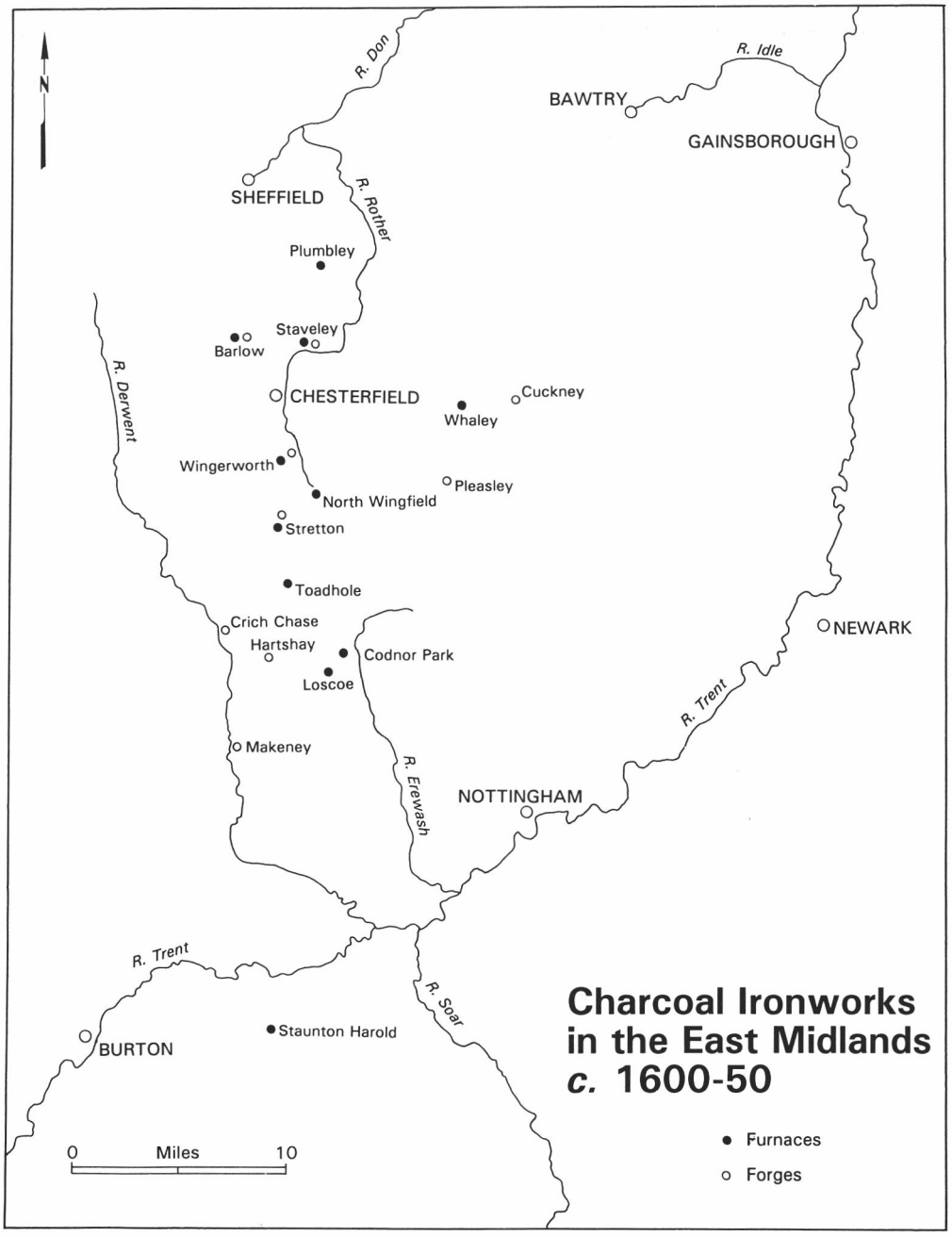
As in most areas, there is a tradition of antiquarian interest in the iron industry of the East Midlands stretching back to the nineteenth century.[9] While there is no general account of the

Industrial Revolution in the region either in print or in an unpublished thesis, the work of G.G. Hopkinson in the 1950s brought together much material on the iron industry which, although vitiated by a lack of proper references, is still useful.[10] Hopkinson worked through all the major manuscript collections then accessible and, while his view of the post-1660 industry was coloured by the traditional view that it was in decline, he identified such problems as increasing pressure on wood supplies and diminishing interest on the part of some ironmasters' families which have been noted by later writers.[11] In his use of ironworks accounts he built on the work of Arthur Raistrick and both drew attention to a lack of innovation and stagnant productivity after 1690, a feature analysed more fully by C.K. Hyde.[12] Some aspects of Hopkinson's account need not be repeated here, such as his description of local supplies or ore, fuel and water-power, or the intricacies of the post-Restoration partnerships. Since 1958 there has been no major work on the charcoal iron industry in the region (rather more has been done on the period after 1790) but new archival material has become available.[13] This article seeks to revise Hopkinson's view of the industry in the light of these discoveries and also considers the ironworks of south Derbyshire, which he did not. Three main phases — the impact of the new technology between 1580 and 1650, the further expansion of the industry after 1660, and its decline between 1750 and the 1780s — are examined in turn, with the aim of establishing which ironworks were in use and by whom, how the fortunes of the local industry compare with those of the iron trade nationally, and, in particular, the stages by which the traditional iron industry declined in the face of competition from new coke-fired works in the second half of the eighteenth century.

## II

Ironmaking in Derbyshire has a long history, although as usual it is impossible to secure an overall view of the industry during the middle ages.[14] Units of production were too small and often too short-lived to allow any estimate of total output or even a chronology for the occupation of bloomery sites. Some indication of the extent of the medieval industry is provided by the list of sites assembled by John Farey in the early nineteenth century where he noticed the slag of bloomeries or charcoal-fired blast furnaces; even after excluding furnace or forge sites (some of which replaced bloomeries) over twenty locations remain.[15] Another rough guide is the occurrence of the element 'smithy' in field- or minor place-names. Again, allowing for some which may simply refer to modern village blacksmiths' forges or those where there has been confusion with the Middle English *smeethe* (i.e. smooth), a picture emerges of an extensive medieval industry on the Derbyshire coalfield, with a preponderance of sites in the Rother valley rather than further south.[16] Occasionally, physical evidence survives to indicate the scale of late medieval or sixteenth-century bloomery operations, as at Wingerworth, where a large dam was known until recent times as Smithy Pond and presumably powered either a bloomery or a bloomsmithy.[17]

A further indication of the size of the industry is the obvious importance of the secondary iron trades in Chesterfield, as revealed by probate inventories. A published volume covering the period up to 1603, for most of which time local ironmaking was based entirely on bloomeries, shows that besides general smiths and nailers there were cutlers and locksmiths in the borough and surrounding townships, including men importing Spanish and Swedish iron. The same picture emerges from seventeenth-century material but what is interesting is that these trades were well established before blast furnace production began.[18] Bloomery ironmaking did not, of course, disappear as soon as blast furnaces began to be built but in most districts it has proved impossible to add an estimate for output by the older technique to that derived from counting the number of furnaces in use during the period in which both existed alongside each other.[19] This is the case in Derbyshire. We know, for example, that an ironworks, which appears to have been a bloomery, existed on the Foljambe estate at Walton, west of Chesterfield, well into the first half of the seventeenth century, but we do not know if this was an isolated example or how much iron was produced there.[20]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Whaley
Wingerworth
Pleasley
North Wingfield
Stretton
Toadhole
Crich Chase
Hartshay
Codnor Park
Loscoe
NEWARK
R. Trent
Makeney
R. Erewash
NOTTINGHAM
R. Trent
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Staunton Harold
BURTON
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Charcoal Ironworks in the East Midlands c. 1600-50
Furnaces
Forges

With the introduction of the blast furnace, knowledge of the scale of ironmaking becomes more precise. The large number of poorly documented bloomeries gave way, first in the Weald and then elsewhere, to a smaller number of blast furnaces capable of producing far greater quantities of pig iron.[21] Because they were major pieces of fixed capital, the new ironworks were built (at any rate in the Midlands) by substantial landowners whose muniments have often survived. For this reason it is generally possible to establish the approximate dates between which sites were occupied and from there one can multiply the number of sites by the average output of a single furnace to produce reasonably reliable estimates of total output.[22]

The earliest blast furnace in the East Midlands was that built by Sir John Zouch of Codnor Castle at Loscoe in about 1582, which was operated in conjunction with a forge at Hartshay, three miles away to the north, and a mill on the Derwent, built to produce iron wire in defiance of a monopoly held by the Company of Mineral and Battery Works.[23] The mill was presumably what later became known as New Mills on the west bank of the Derwent, opposite another mill site at Makeney, the two together being known as Makeney or New Mills forge. The builder of these works was dead by 1588 and was succeeded by another John Zouch who, heavily in debt, borrowed from his neighbour Sir Francis Willoughby of Wollaton in return for a lease of the ironworks at Loscoe, Hartshay and Makeney. A scheme to build a second furnace at Codnor in addition to that at Loscoe envisaged in 1591 had not been carried out by 1594, which led R.S. Smith to conclude that it never was, although evidence from Heanor parish register suggests that there were two furnaces in operation at the beginning of the seventeenth century.[24] The site at Loscoe is still clearly indicated by a large dam on a tributary of the Erewash; the Codnor Park furnace was probably built on another tributary near the northern edge of the park, where a mill was still in use in the 1760s[25] but was submerged by the Cromford Canal reservoir in the 1790s. Accounts survive for the Zouch ironworks for several months in 1591 when they were in Willoughby's hands, but by 1609 the Zouches appear to have recovered full possession.[26]

In the Rother valley the earliest furnace seems to have been that at Stretton, south of Chesterfield, which is first mentioned in 1593 in a volume of Hardwick Hall accounts; these also record sales of bar iron for the period 1594-1606, indicating the existence of a forge as well. Stretton at this date formed part of the extensive north Derbyshire estates of the Earl of Shrewsbury, who in the 1570s was operating a bloomsmithy there.[27] A similar pattern is evident at Barlow on the other side of Chesterfield, another Shrewsbury manor, where there was a bloomery in 1578 and a furnace erected in 1605-6, with a forge lower down Barlow Brook.[28] The Shrewsburys' final venture into ironmaking in Derbyshire was at Toadhole, on their Shirland estate in the Amber valley, where the building of a furnace was discussed in 1609 and the scheme presumably carried out shortly afterwards.[29] The furnace, which operated in conjunction with a forge at Crich Chase in the Derwent valley a few miles to the west, is mentioned in 1620 and in the 1640s was the subject of a lengthy dispute between the widow of Sir William Savile of Rufford (Notts.) and Sir Francis Nevile of Chevet (Yorks.), steward of the Derbyshire and Yorkshire estates of the Shrewsburys' successors, the Earls of Pembroke. Whereas Toadhole furnace was in use later in the seventeenth century, the forge at Crich was destroyed during the 1640s and never rebuilt.[30]

Three gentry families followed the example of the Talbots and built blast furnaces in the Rother valley early in the seventeenth century, in at least one case superseding a bloomery. This was at Wingerworth, where, according to Farey, a charcoal-fired furnace which closed in 1784 had been in existence for more than 180 years. Because of the loss of most of the Hunlokes' muniments it is difficult to confirm that Wingerworth was amongst the earliest furnaces in the region, although deeds abstracted in the eighteenth century show that a bloomery was the first property the family acquired from the Curzons in 1547, a generation before they bought the manor and most of the land of the parish.[31] The deeds do not mention a furnace but it seems reasonable that the Hunlokes should have experimented at an early date with the new technique,

added to which Farey was normally well informed in matters to do with the iron industry. There was a forge a short distance downstream from the furnace. A few miles to the south-east, a plan of 1621 of Sir Francis Leeke's Park Hall estate in the parish of North Wingfield provides the earliest evidence for a furnace on the Rother between Danesmoor and Park Houses, presumably built some time in the previous twenty years. This appears to have operated in conjunction with a forge at Pleasley, some miles away to the east, which is said to have been built in 1611.[32] Rather less is known of the origins of the ironworks at Staveley, apparently first mentioned only in 1639, but by analogy with other sites around Chesterfield the furnace and forge, which lay some way west of the village, must have been established earlier in the century by the Frecheville family.[33]

To the east of the Rother valley, on the magnesian limestone close to the border with Nottinghamshire, a furnace was built on the Earl of Kingston's estate at Whaley in 1617 together with a forge further east again at Cuckney. The two works were established by one Martin Ash, who soon became insolvent and both furnace and forge reverted to Kingston, who still had them in hand in 1632.[34] At the opposite end of the region, a furnace was in use on the Shirley estate at Staunton Harold by 1606, if not earlier, which in 1624 was leased to John Wenham of Battle, Sussex, apparently the only instance of Wealden investment in the East Midland iron industry. A furnace site nearby at Foremark, noted by Farey, at present has no known history, either before or after the Civil War.[35]

By the mid-seventeenth century the earliest ironworks in the East Midlands appear to have been abandoned. There is no evidence for the occupation of the furnaces at Codnor Park and Loscoe, or the forge at Hartshay, beyond about 1620, although the mill at Makeney remained in use.[36] Toadhole furnace appears to have been derelict in the 1650s.[37] In the Rother valley a group of six furnaces was at work, three of them with forges. By the 1650s Barlow forge had been converted to a cornmill but the other sites remained in use.[38] With the exception of Whaley and Cuckney, all these early ventures shared certain characteristics common to ironworks of the same period elsewhere. The furnaces were built close to ore and fuel on streams which provided a reliable source of power. Where furnace and forge had been built in tandem the forge was up to half a mile downstream from the furnace. All the sites had been established either by the major local magnates, the Talbot Earls of Shrewsbury, or one of the wealthier gentry. Somewhat oddly, the greatest of the sixteenth-century Scarsdale gentry families, the Foljambes of Walton near Chesterfield, appear to have retained bloomery ironmaking after their neighbours had given it up; possibly by 1600 their fortunes were already on the wane and they lacked the resources to engage in new capital expenditure.[39] For the most part, the first generation of Derbyshire ironworks seem to have been managed directly by the owners of the land on which they stood. This was certainly the case with Sir John Zouch's works (apart from the assignment to Willoughby) and those at Wingerworth and Crich, while the ironworks at Staveley was described as 'Mr Frecheville's' in the 1640s.[40]

Wingerworth is the only furnace where anything is known of output in this period. In 1657, during a dispute over the management of the Hunloke estate (and especially the fate of a considerable amount of timber), an ironfounder named John Barker spoke of taking in nearly 500 loads of charcoal for the ironworks in 1654; another deponent testified that about 2,200 cords of coppice wood had been cut down to make iron, which he valued at 6s. 8d. a cord.[41] According to Hammersley's figures, 2,200 cords of wood would have made some 700 loads of charcoal.[42] If all this had been used for smelting, Wingerworth furnace might have made as much as 250 tons of pig in a year; even the lower figure of 500 loads mentioned by the founder would have made nearly 200 tons. On the other hand, if the charcoal had also supplied the forge (which seems likely), some 6-7 loads would have been needed to carry out both stages of manufacture and the final output of bar iron may have been as low as 120 tons from 700 loads of charcoal or 70-80 tons from 500 loads. Wingerworth forge was disused by the early eighteenth century, when the first of the contemporary lists of forge output was published, but a figure of 100 or 120 tons would

correspond closely with what other local forges were producing at this date.[43]

It is possible to relate the size of the local industry roughly to the national picture by looking at the number of occupied furnace sites, although this ignores the differing size of furnaces in various regions. Between 1600 and 1650 there appear to have been up to seven furnaces in use in Derbyshire, compared with an average of 82 throughout England and Wales, which illustrates the limited importance of the region in a national context. When the Loscoe furnace was built in the 1580s there were already more than seventy furnaces in use elsewhere, mostly in the Weald.[44] More elaborate calculations are of doubtful value in view of the fragility of local furnace chronology.

Little is known of the distribution or consumption of iron produced in Derbyshire during this period, apart from Sir John Zouch's wiremaking venture at Makeney. Much of the iron presumably went to supply smiths in Chesterfield and smaller places and some was consumed directly by producers, for example by the Countess of Shrewsbury during her building campaign at Hardwick in the 1590s.[45] How much iron was being sent out of the region is less clear, nor do we know how much imported iron was reaching local smiths. The Hull port books for the first half of the seventeenth century show both imports of bar iron from Sweden and shipments coastwise to London and elsewhere. Since, however, Hull served not only the Derbyshire iron industry but also that of south Yorkshire, it is impossible to separate the trade of the two regions (whereas in the case of shipments of lead through Hull, the Derbyshire origin of the traffic is more obvious).[46]

## III

Between 1650 and 1750 six new blast furnaces were established in the East Midlands. Foxbrooke near Eckington was built in 1652;[47] twenty years later (1673) a lease was obtained to build a furnace at Kirkby-in-Ashfield, the first new works in the Erewash valley for nearly a century.[48] Of the older sites, Toadhole furnace was evidently back in use by the 1680s, although it was omitted from the country-wide list of furnaces of 1717. On the other hand, it appears in a list of charcoal furnaces closed between 1750 and 1787 and so was presumably in use at least intermittently in the eighteenth century.[49] To counterbalance these developments, three Rother valley sites were abandoned. Stretton furnace is not heard of after the 1650s, nor is North Wingfield after the 1660s.[50] Barlow was still in use in the 1690s but cannot be traced beyond about 1710.[51] The net effect of these changes was that throughout the period 1650-1750 there were at least six furnaces at work, during a period in which the number of sites occupied nationally averaged 77 without much variation up or down. Derbyshire thus conformed to the general picture in displaying no long-term decline in output until after 1750, although unlike, for example, South Wales and Furness, there was little real growth in the number of furnaces or, presumably, output.

The continuing vitality of the East Midland iron industry is also illustrated by attempts to smelt the rather thinner ores of the south Derbyshire coalfield. A furnace at Hartshorne is mentioned in 1699 and 1702 but described as disused by William Woolley in 1712;[52] another at Melbourne is first documented in 1735;[53] and the Staunton Harold furnace is included in the list of those closed between 1750 and 1787, a reference which may correspond with archaeological discoveries in the early nineteenth century.[54]

Overall, the number of furnaces in use in the region in the first half of the eighteenth century was probably eight, about one-tenth of the total for Great Britain. This gives the region a greater share of output than one derived from the earliest furnace-by-furnace estimate, compiled in 1717, which includes five furnaces in the East Midlands with an annual output of 1,000 tons, some 5 per cent of the total. In fact, this survey can be shown to be incomplete and the total output given there (18,190 tons) too low. Hammersley's estimate of 25,000 tons from about 80 furnaces is probably to be preferred.[55] The only local furnace for which actual output figures are recorded

is Wingerworth, which between 1744 and 1756 made an average of 272 tons a year, the annual totals ranging from 125 to 506 tons.[56]

Changes in the number of forges confirm the impression that output did not begin to fall until after 1750. Here, however, there was a marked shift in location, away from the coalfield and the furnaces east towards navigable water and in the direction in which iron destined for consumption outside the region travelled. Barlow was disused by the 1650s, while Stretton probably closed about the same time.[57] Wingerworth forge, still in use in 1681, had become a red-lead mill by 1717.[58] In place of these sites, two sites on the dip-slope of the magnesian limestone are first mentioned around the middle of the seventeenth century, Clipstone and Carburton, in the same district as the older established forges at Cuckney and Pleasley.[59] Some miles away to the south-east a mill at Bulwell is first described as a forge in 1615 and was certainly in use from the 1660s.[60] This stood on the Leen six miles north of Nottingham, well positioned to receive pig intended to be refined and sent on to the Trent. The other Nottinghamshire forges were similarly located between the furnaces to the west and Bawtry to the north-east, the traditional shipping-place for the industrial products of north Derbyshire and north Nottinghamshire.[61] In the Rother valley, only Staveley forge remained in use.

In the Derwent valley the site at Makeney became a scythe-mill after the demise of the Zouch enterprise but was in use as a forge again by the end of the century.[62] Further south, there do not appear to have been forges immediately associated with the furnaces at Hartshorne, Melbourne or Staunton Harold; pig from Melbourne certainly went to Burton for refining while in the 1670s the family who were later operating the Hartshorne furnace had a forge in the same district at Whitwick.[63] Another forge, at Barton Fields on a tributary of the Dove north of Burton, was working in Woolley's day and until at least the 1760s.[64]

The growing dispersal of the industry is also apparent in the siting of rolling and slitting mills. This new piece of water-powered machinery, capable of producing plate and rod iron in greater quantity and variety than was possible with a forge hammer, appears to have been introduced into the East Midlands in 1656 at Renishaw, about a mile from Foxbrooke furnace.[65] By contrast, the rolling and slitting mill at Makeney cannot be traced before the eighteenth century.[66] Lower down the Derwent, a mill at Wilne was in use as a rolling mill by the 1730s;[67] a site at Derby became a slitting mill in 1734;[68] and another at Borrowash was similarly taken over in the 1760s.[69] The choice of these sites was probably determined at least in part by their proximity to navigable water: after 1720 mills on the lower Derwent could despatch finished work down the river (opened that year for navigation to Derby) and then either up the Trent to Burton and thus by land to Birmingham, or downstream to Gainsborough, Hull and London. Iron sent from local forges presumably travelled by land but the mills may also have received material from the Burton forges or used Russian and Swedish bar imported at Hull.[70] For both forges and mills, closeness to a navigable river was important for the distribution of finished goods but whereas for forges this had to be balanced against the desirability of being within easy reach of the furnaces and supplies of pig, the mills may have consumed as much imported bar as locally produced iron and were thus doubly attracted to a site on or near the Trent. In the 1770s Bulwell and Makeney were both using Baltic iron alongside local pig.[71]

The increase in the number of forges and mills in the Trent valley should perhaps also be seen as part of the centrifugal tendency of the Birmingham iron industry.[72] Faced with growing pressure on water-power resources in the town itself, the industry spread outwards both north and south towards areas such as Derbyshire, where iron eventually consumed in the Birmingham area was smelted, or simply nearer the Trent, up which imported bar destined for Birmingham was brought.

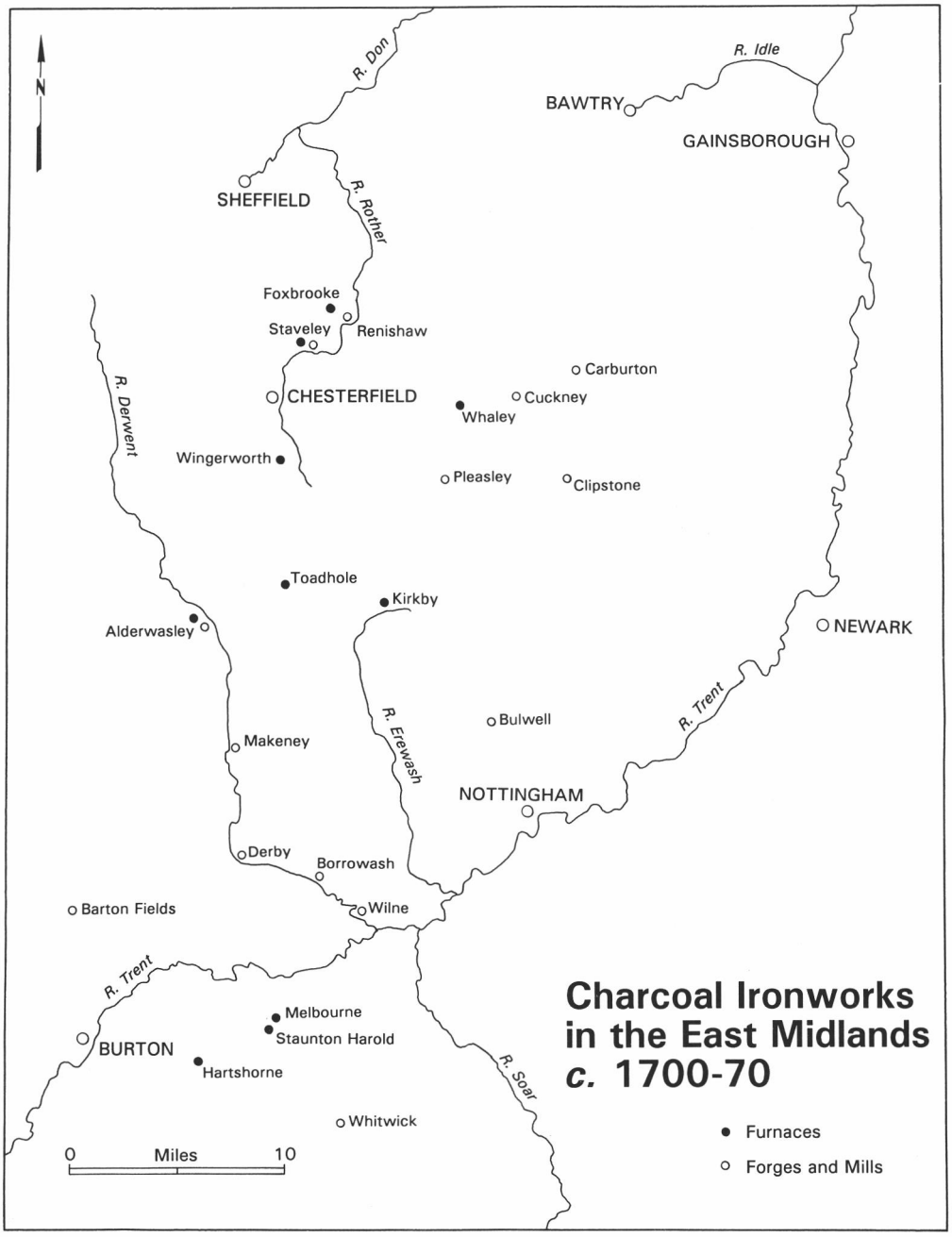
During the century up to 1750 the East Midland iron industry, while not greatly expanding, certainly did not decline, and underwent a considerable restructuring. Who was responsible for this reorganisation? Not in general landowners, who now fell back to leasing sites for others to develop. Nor, for the most part, were the ironmasters of Nottinghamshire and Derbyshire

between 1650 and 1750 local men. This is the period in which the industry became tightly integrated through wide-ranging partnerships which brought works a hundred miles or more apart into the hands of a single ironmaster and, with improvements in river transport, this led to the extensive movement of semi-finished iron between regions.

The first of the new ironmasters, and one of the few local men involved in the industry before 1750, was George Sitwell of Renishaw, whose family were among the wealthier gentry of seventeenth-century Scarsdale.[73] In the 1640s Sitwell and his father-in-law, Henry Wigfall of Carter Hall, operated a furnace at Plumbley, near Eckington, sending pig to a forge at Stone, near Tickhill in south Yorkshire. In 1649 Sitwell gave up his interest at Plumbley (which seems to have been abandoned shortly afterwards) and three years later built a furnace of his own at Foxbrooke, operated in conjunction with the slitting mill near Renishaw and sites leased from others, including the Leekes' furnace at North Wingfield and forges at Carburton, Clipstone and Pleasley. Some of the products of these works were sold locally; in particular, much of the rod iron must have gone for nailmaking in Eckington, where the craft survived until the nineteenth century. Other iron was sent further afield, with a considerable quantity going each year to London, where Sitwell had a cousin working as his factor. One wonders how far Sitwell's sales here represented a new development in the 1650s and how far he was carrying on a trade begun earlier in the century. It is difficult, in the absence of operating accounts, to know for how long Derbyshire iron had been exported via Bawtry along a route also followed by lead mined in the Peak and smelted at sites between the Derwent and Chesterfield. Was it, as appears to have been the case with the lead trade, a late sixteenth-century development stimulated by the sixth Earl of Shrewsbury, who was as much involved in lead smelting as the iron industry, and was certainly concerned to improve port facilities at Bawtry,[74] or did it have a longer history, stretching back to before the introduction of the blast furnace? As in the period before the Civil War, it is difficult to draw conclusions from the Hull port books on this question because of the intermixture of Derbyshire and south Yorkshire iron passing through the port.

During the 1650s and 1660s Sitwell's great rival in the local iron trade was William Clayton of Whitwell, who was the Frechevilles' tenant at Staveley until his death in 1666. George Sitwell died the following year and his business, unlike Clayton's more limited activities, was continued by his descendants until the 1690s.[75] With the retirement of this family from the industry most of the local works fell into the hands of West Midland ironmongers, whose main interests lay in the Birmingham area or the Severn valley. In the 1690s a partnership centred on the Foley family of Herefordshire and managed by John Wheeler of Woollaston Hall, Stourbridge, leased the group of works previously held by the Sitwells or Clayton: Staveley and Foxbrooke furnaces, Staveley and Carburton forges, and Renishaw mill. North Wingfield furnace was presumably out of use by this date. At the same time John Jennens of Erdington Hall near Birmingham was leasing Kirkby furnace, which his father Humphrey had built in 1673, together with another at Barlow and the forges at Makeney and Pleasley. In 1702 Jennens took over Wingerworth furnace, previously held by a fellow Birmingham ironmonger, Thomas Pemberton, who in 1681 had himself succeeded Thomas Bretland, a Chesterfield lead merchant who may have been the Hunlokes' first tenant. Jennens's name also occurs in 1699 as tenant of Hartshorne furnace, a site whose earlier history is undocumented.[76]

Together these partnerships accounted for most of the East Midland industry, apart from Whaley and Toadhole furnaces, and some of the Nottinghamshire forges, for which no tenants' names are known. During this period, part of the region's output was sold neither locally nor in London, but was going south via Rugeley to Birmingham. As Johnson pointed out, although the output of the mill at Renishaw was only a trickle compared with the flood from those in Staffordshire, it was obviously possible for Derbyshire and Nottinghamshire to supply the Birmingham region. By analogy, Jennens's works were probably producing for the same market.[77] Since the journey between these works and south Staffordshire would presumably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R. Don
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BAWTRY
GAINSBOROUGH
SHEFFIELD
R. Rother
Foxbrooke
Staveley
Renishaw
R. Derwent
CHESTERFIELD
Carburton
Cuckney
Whaley
Wingerworth
Pleasley
Clipstone
Toadhole
Kirkby
Alderwasley
NEWARK
R. Trent
R. Erewash
Bulwell
Makeney
NOTTINGHAM
Derby
Borrowash
Barton Fields
Wilne
R. Trent
Melbourne
Staunton Harold
BURTON
Hartshorne
R. Soar
Whitwick
0 Miles 10
Charcoal Ironworks in the East Midlands c. 1700-70
Furnaces
Forges and Mills

have been by land carriage, rather than a circuitous route via Bawtry, the Idle and the Trent to Wilden Ferry, it is hardly surprising to find Birmingham ironmongers petitioning in the 1690s in support of one of the several bills to make the Derwent navigable from Derby to the Trent, since that would have shortened the land carriage by some miles.[78]

After the departure of Foley, Wheeler and Jennens from the East Midlands, the industry entered the final phase of the charcoal era in which works in the northern half of the region came under the control of a partnership whose main interests lay in south Yorkshire. At the beginning of the eighteenth century the Spencer family took over what became the 'Nottinghamshire and Derbyshire' works previously run as a group by Foley and before that by Sitwell, i.e. Staveley and Foxbrooke furnaces, Staveley and Carburton forges and Renishaw mill.[79] The works lost their connection with the West Midlands and turned instead, as they had in Sitwell's time, to the local nail trade or to London. Wingerworth furnace was given up by Jennens in 1710 and in 1717 was leased to another Birmingham ironmonger, Riland Vaughton, who himself handed over to a syndicate of local men headed by the Chesterfield lead merchant William Soresby in 1725.[80] Barlow appears to have been abandoned after Jennens surrendered the lease.[81]

Meanwhile, a family named Mather, whose connection with the iron trade seems to have originated at Bulwell forge in the early eighteenth century, enlarged their activities around the middle of the century by acquiring most of the works operated fifty years before by Jennens, including the forge at Makeney, which was in their hands by 1750; Wingerworth furnace, leased in 1751; a site at Borrowash, where a rolling mill was erected under a lease of 1763; and the furnaces at Kirkby and Hartshorne, the latter apparently put back into use.[82] The Mathers' activities were focused towards the Trent valley rather than Bawtry, with pig from Wingerworth and Kirkby going south to Makeney, Bulwell and Borrowash. South of the Trent, the furnace at Melbourne was operated between 1758 and the 1770s by the Lloyds of Birmingham as their only venture into smelting. They had previously been ironmongers and then forgemasters; pig from Melbourne went via the Trent to Burton for refining and then into the Birmingham metal trades.[83] Presumably the Staunton and Hartshorne furnaces were supplying the same market.

The early eighteenth-century East Midland iron industry showed none of the characteristics of decline once attributed to this period. The number of works remained roughly stable and, in addition to supplying local markets, the region played a full part in the wider trade in semi-finished iron. Indeed, positioned as it was between Birmingham and Sheffield, the two main centres of the secondary metal trades, it was able to supply both. On the other hand, as in most ironmaking districts, there were no technological changes in the East Midlands until after 1750: the region was not the scene of any early attempt at coke-fired smelting (as, for example, occurred in both North East England and the North West), much less the successful adoption of coke in the blast furnace, as at Coalbrookdale. Nor was there any significant addition to capacity, with the building of new furnaces, as was the case in South Wales.[84]

## IV

By 1790 90 per cent of British pig iron was smelted with coke;[85] in the East Midlands the proportion reached 100 per cent six years earlier. The region, with its 10 per cent share of output, was typical of the mainstream of the industry in seeing a gradual decline of charcoal-fired smelting, rather than a sudden collapse. Eight local sites appear in a list of furnaces closed between 1750 and the 1780s either for want of fuel or because of the introduction of coke-fired smelting.[86] Of these, Toadhole, Hartshorne and Staunton have virtually no other recorded history; Melbourne appears not to have been re-occupied after it was given up by the Lloyds in 1773;[87] and Whaley was in blast in 1752-6 but then stood idle until handed back to the landlord in 1769.[88] None of these sites was re-used, although an unsuccessful attempt was made at Moira, a few miles south-west of Melbourne, in 1806 to establish coke-fired smelting on the Ashby coalfield.[89]

The first step in the transition from charcoal to coke in the East Midlands came in 1764, with the building of a blast furnace and forge on the banks of the Derwent at Alderwasley by Francis Hurt, a member of a substantial Low Peak gentry family which also had interests in the lead industry.[90] It is not absolutely clear whether the furnace was intended to be charcoal- or coke-fired and it may have used both at different dates. If conceived on entirely traditional lines, then Alderwasley appears to have been the last charcoal-fired blast furnace built anywhere in Britain (apart from an attempted revival in Hampshire in the 1860s);[91] if coke (or raw coal) was used either initially or later, then the furnace marks the beginning of the coke era in the East Midlands. In 1776 Hurt enlarged his activities by building a second forge a little lower down the Derwent; more important was his decision in 1780 to build a coke-fired, steam-blown blast furnace at Morley Park, an estate a few miles south-east of Alderwasley which he had bought in 1767, mainly as a source of ironstone for his works.[92] Although not the first coke-fired furnace in Derbyshire (two at Chesterfield had each been operating for about three years in 1780),[93] Morley Park is of some interest, partly as the successor to what may have been an experimental venture at Alderwasley and partly because it marked further investment in the iron industry by a major landowner (who continued to operate the works himself until 1811) at a time when most similar families in Derbyshire and Nottinghamshire were leasing works to professional ironmasters.

Of the older sites in the region, the only places which made the change from charcoal to coke were Staveley and Wingerworth. In 1765 the partnership which had operated Staveley and its associated works since the beginning of the eighteenth century was remodelled and the Derbyshire and Nottinghamshire works transferred to a new syndicate of Sheffield ironmasters.[94] The operation had been reduced in scale in 1749 with the abandonment of Foxbrooke furnace, converted the following year into a sickle mill, but the other sites (the furnace and forge at Staveley, the mill at Renishaw and the forge at Carburton) continued in use until the expiry of the Staveley lease in 1783.[95] At Wingerworth, accounts for 1772-77 show that the furnace mainly supplied Bulwell and Makeney forges, apart from small sales of pig to foundries in Chesterfield. It is possible that the furnace shut down in 1777: account heads have been ruled for 1778 but not used, although there is no explicit statement that the furnace was blown out.[96] The Hunlokes made a new lease of their ironworks in 1781 to two men with no previous connection with the region: George Matthews, a Broseley iron merchant, who had been involved in coke-fired ironmaking in Shropshire since the 1750s, and Joseph Butler, a lawyer and land surveyor of York, who seems to have had no other interests in the industry. The lease was in some respects identical to those of the previous eighty years, with similar covenants concerning the ironstone, cordwood and the good management of the furnace. In other ways, it marked the beginning of a new era, since besides demising the 'furnace now in workmanship' the lease allowed Matthews and Butler to build 'any other Iron Furnace or Furnaces Building or Engines for the Casting of Iron or Iron Metal', and included a lease of most of the Hunlokes' coal. It is impossible to tell whether the charcoal-fired furnace, described elsewhere in the lease as the 'Old Furnace', was in blast in 1781; what is certain is that a new coke-fired furnace was built almost at once a short distance away.[97]

The rest of the charcoal iron industry in the region seems also to have disappeared in the early 1780s. At Cuckney and Pleasley, forge-sites were taken over for cotton mills, as happened also with the rolling mill at Wilne.[98] The forge at Barton Fields has no recorded history after the 1760s[99] but was presumably abandoned sometime in the following ten or twenty years. The only forge which remained in use (apart from Staveley) was Alderwasley, which survived the abandonment of the short-lived blast furnace there to operate in association with the coke-fired furnace at Morley Park.[100]

The reasons for the gradual decline and final extinction of the traditional iron industry in the East Midlands are presumably a combination of the general and the particular. Coke-fired smelting was introduced at Coalbrookdale in 1709; initially successful only in the production

of castings, the innovation had little appeal to an industry 90 per cent of whose output was bar iron. In the 1750s, however, the technique was adopted elsewhere in Shropshire and then in other regions, especially South Wales, for the manufacture of forge pig. Hyde argued that the timing of this diffusion can be explained by a sharp rise during that decade in the price of charcoal, so that coke-smelted pig became decisively cheaper. Alternatively, one can give more weight to the contemporary view that there was a definite technological breakthrough at Coalbrookdale around 1750, which made possible the production of forge pig with coke for the first time.[101] Whatever the reason, an increasing quantity of pig was coke-smelted, the proportion of total output reaching 50 per cent around 1775 and increasing more rapidly thereafter. During the third quarter of the century the number of charcoal-fired furnaces declined steadily; after 1775 closures became more frequent until by 1790 only about two dozen remained, mostly in the Furness district or South Wales.[102]

This general trend no doubt explains in part the abandonment of several furnaces and forges in the East Midlands after 1750. The ledgers of the Fell partnership show the gradual loss of more distant markets: accounts with London merchants, who in the early eighteenth century took a large proportion of the group's output, shrank year by year, reflecting the contraction of the market nationally for charcoal-smelted iron. On the other hand, the same source shows that it was still possible to produce iron profitably using traditional methods in the second half of the eighteenth century. Even if some markets might be lost, local nailmakers and edge-tool manufacturers remain in evidence until the surviving accounts end in the 1770s. Since Fell continued to work Staveley until the expiry of the lease in 1783 he was presumably making at least a modest profit: inertia alone cannot explain the survival of the enterprise a full thirty years after the younger Darby's breakthrough at Coalbrookdale. Although, as both Raistrick and Hopkinson suggested, the partnership's works might seem technologically stagnant, this was not wholly the case. In 1759 Fell sent a man to Coalbookdale 'to learn how to blow with Ground Coaks' and tried the new method at Chapel furnace near Sheffield the same year. The attempt was unsuccessful, as it was at Staveley, where 'part of the Stone [was] burned with coaks' in 1764-5 but in 1766 charcoal alone was used.[103]

Forge technique, both at Staveley and elsewhere, also remained generally traditional. The only forges in the East Midlands which adopted the 'potting' method of making bar iron with coke as the fuel, a process which by 1790 accounted for about half the total output of bar iron (mostly, one assumes, using coke-smelted pig), were Mather's at Makeney and a forge at Chesterfield built by David Barnes, who established a coke-fired blast furnace on the canal there shortly after it was opened in 1777. Even after rebuilding in 1782, Alderwasley retained the finery-chafery technique.[104]

According to Hyde, the rising price of charcoal, which accounted for between half and two-thirds of the final cost of pig-iron, was chiefly responsible for the abandonment of charcoal-fired smelting. The detailed cost accounts that survive for the Fell partnership up to 1772 make it possible to look at fuel costs for Staveley and Carburton. In 1762-3 the average cost of charcoal for the three works was about 27s. a dozen; by 1771-2 the cost had risen to 30s., which was also the value placed on stocks of charcoal when inventories were drawn up in 1773. Most of this increase took place between 1763 and 1766 and at the end of the 1765 campaign the book-keeper noted that the price had risen by 1s. 9d. a dozen from the previous year. This was the only occasion on which the increase was commented on and it may well be significant that it was precisely during these years that Fell tried to smelt with coke.[105]

The final cost of charcoal was made up of four elements: the cost of cordwood, the cost of cording and coaling, and the cost of transporting the charcoal to the ironworks. The Fell accounts record the same figures (6d. per cord and 3s. per dozen) for cording and coaling throughout the period 1762-72; the increase in charcoal costs must therefore be attributable to an increase in either wood prices or the cost of transport or a combination of the two. Staveley and Carburton

drew their charcoal from a number of sources, paying between 7s. and 10s. 6d. a cord. The cost of leading varied similarly, depending on the distance to the works at which a particular consignment was used. The average cost of both cordwood and transport in any one year thus varied according to the mix between cheaper and more expensive wood and between short- and long-distance carriage. The average cost of leading a dozen of charcoal to one of the partnership's two sites was the same in 1772 as 1762, i.e. about 6s. 6d. The range of wood prices did not change, but the balance shifted towards the upper end: in 1762 the partnership paid on average about 9s. a cord and in 1772 10s. This increase affected all three works (the furnace and forge at Staveley and Carburton forge) roughly equally and differentials did not change. Carburton consistently obtained its wood more cheaply than Staveley, presumably because of its position in Sherwood, closer to more extensive reserves of cordwood. Rising fuel prices were thus the result of rising wood prices, not an increase in carriage costs resulting from the partnership having to look further afield for supplies. Not only did the average cost of leading remain the same, but the same woods and wood-owners are named year after year.

A slightly different picture emerges from the less detailed accounts for Walter Mather's activities at Wingerworth in the 1770s. The Hunlokes regularly demised their cordwood with the furnace in the eighteenth century, charging 9s. a cord in a succession of leases from 1741 to 1781. Mather's accounts show that the bulk of his charcoal came from Hunloke woodland close to the furnace, in particular Hardwick Wood (about 250 acres) less than half a mile away. Shortly before Mather took up the lease in 1758 he listed 1,380 cords available to the furnace each year, including 300 from the Hunloke estate, and commented: 'I may moderately expect to buy 1200 Cord which will be sufficient to blow 300 Ton'. In the 1770s Mather was paying 4s. a load for coaling and on average about the same for leading, reflecting the shorter distance over which most of his charcoal had to be brought. Like Fell, Mather was paying between 7s. and 10s. a cord for the wood itself with the average falling near the top of this range, since the largest single source was the Hunloke estate, where a price of 9s. was prescribed in the lease.[106]

Although the price of charcoal at Wingerworth in the 1770s was roughly the same as at Staveley and Carburton, there is no evidence for any shift up or down in Mather's fuel costs, except in so far as the average price of wood per cord varied depending on the proportion of the total drawn from different sites, at some of which the price might be slightly above or below that charged by the Hunlokes. Indeed, the fact that the Hunlokes continued to lease their cordwood with the furnace at exactly the same price over a period of forty years, during which Hyde claimed that there was a sharp increase in charcoal prices nationally, rather argues in favour of Hammersley's view that the market in charcoal for the iron industry was essentially artificial, with prices determined as much by custom as short-term variations in market conditions.[107] In particular, since charcoal could not easily be transported over distances of more than about five miles, without risk of damage to a friable and easily crushed product, both wood-owners and ironmasters had a degree of monopoly power at their disposal. A landowner with coppice-wood on his estate had little choice, especially in the second half of the eighteenth century as the number of industrial consumers for charcoal declined, but to sell to a local ironworks; equally, an ironmaster would seek to obtain charcoal from woods within a few miles of his works. Long-term agreements such as those embodied in the Hunloke leases, under which an ironmaster took furnace and cordwood from the same estate, thus suited both sides. The landlord was assured not only rent for the ironworks but also income from the sale of cordwood, while the tenant was guaranteed exclusive access to a nearby source of fuel without which he could not operate the works successfully. Peace of mind for both landlord and tenant may therefore have counted for more than any desire to seek short-term advantages from changes in the price of charcoal from year to year.

The importance of the iron industry as a customer for charcoal in this period is well illustrated by a volume of wood accounts for the Hurt estate at Alderwasley, extending from the 1740s to

the 1760s.[108] This shows that timber in various forms was cut and sold annually but by far the largest source of income was from sales of cordwood for charcoal making. During the 1750s Walter Mather was regularly taking 1,200 cords a year under a long-term agreement, presumably to supply his forge and mill at Makeney. Interestingly, the price of wood under this agreement was once again 9s. a cord and remained the same during precisely the decade in which Hyde detected an increase in fuel costs for the charcoal iron industry. There is no evidence for any such increase in the Hurts' accounts, rather a further indication that the price of cordwood tended to be stable over a long period. It is even possible to suggest (although there is no firm evidence to support the idea) that one reason for Francis Hurt's entry into the charcoal iron industry as late as 1764 was to provide an outlet for cordwood from his estate which, for some reason, Walter Mather no longer wished to buy.[109] At any rate in the East Midlands, there seems little reason to believe that the traditional iron industry was being driven into extinction by rising fuel prices, either in the 1750s or later.

How then are we to explain the demise of the charcoal-fired furnaces and forges in Derbyshire and Nottinghamshire in the second half of the eighteenth century? As elsewhere, the local works generally survived the initial expansion of coke-fired ironsmelting in the 1750s, a decade in which the total output of the industry increased through the building of new furnaces designed to use coke from the start, rather than the conversion of existing furnaces, and few charcoal-fired furnaces actually closed. The East Midlands then shared in the general contraction of the charcoal iron industry of the 1760s and 1770s.[110] Some furnaces, however, including those at Wingerworth and Staveley, survived, presumably profitably. Part of the explanation may lie purely with the difficulties of mastering a new technique. Whatever the relative costs of charcoal- and coke-fired smelting, there may still have been technological problems. Fell experimented with coke at Chapel within a few years of the younger Darby's breakthrough at Coalbrookdale and tried again at Staveley five years later when his charcoal costs rose sharply. He failed and coke-fired smelting was not adopted at Staveley until the site changed hands and the furnace was rebuilt in the 1780s. Coal may have been cheaper than wood but this was no comfort to an ironmaster whose furnace would not smelt satisfactorily with coke or whose workmen could not understand the new process. With a well established, if not expanding or necessarily very profitable operation, based on tried and tested methods, and with a lease which had several years to run, there was little inducement for Fell to engage in the major capital expenditure required to rebuild Staveley furnace and go over to a technique of which he had no experience. Even as late as 1775 nearly half the pig produced in Britain was still smelted with charcoal[111] and those ironmasters who were still operating at a profit presumably saw no reason to give up. This might seem no more than inertia but it seems unlikely that men such as Fell and Mather would have remained in an unprofitable business. The sheer bulk of the immaculately kept journals and ledgers, with their minute calculations at the end of every campaign, is surely evidence that the partnership headed by Fell knew where it stood each year.

The closure of the last charcoal ironworks in the region may be explained partly in terms of national factors but must also owe something to local circumstances. In Derbyshire the building of the canals seems to have been particularly important. The canal from Chesterfield to the Trent, replacing the land carriage route to Bawtry and the Idle from there to Stockwith, was promoted in 1769-70 partly at the instance of the lead industry and partly because the Cavendish estate sought better transport facilities for their ironworks at Staveley.[112] Within a couple of years two coke furnaces had been built on the outskirts of Chesterfield by men who in one case (David Barnes) had previously been engaged in coalmining and in the other (Ebenezer Smith and his partners) in the Sheffield metal trades.[113] In south Derbyshire the Erewash Canal was also completed in 1777 and was probably the main reason for to the establishment of a coke-fired blast furnace on its banks at Stanton in 1787.[114] When the canal was extended in 1789-93 further up the Erewash valley to Pinxton and into the Derwent valley as far as Cromford two much larger

ironworks were built alongside at Butterley and Riddings.[115]

The opening of the Chesterfield Canal may well have been the immediate stimulus which led not merely to the building of the two new furnaces at Chesterfield itself but also the rebuilding of those at Wingerworth and Staveley. When the Staveley lease expired in 1783 the existing tenants offered to build a coke-fired furnace. This was turned down by the Duke of Devonshire's agent, who had himself investigated coke-fired smelting at Coalbrookdale, and the lease was offered on the open market. The value of the site, standing virtually on the banks of the Chesterfield Canal, must have appreciably increased in recent years and by this date it would have been clear to anyone interested in the industry, as either landlord or tenant, that the future lay with coke-fired smelting, now responsible for 80 per cent of total output. Out of three contenders, one of them David Barnes, the agent chose Walter Mather, who agreed to rebuild the works with a coke-fired furnace, steam blowing-engine and forge (the latter apparently consisting of a traditional finery and chafery, not a potting forge). As a consequence of this lease, the sites at Carburton and Renishaw, with which Staveley had operated for more than a century, were abandoned.[116]

Having taken the works at Staveley, Mather restructured his interests throughout the region by giving up Bulwell and Borrowash to cotton-spinners looking for mill sites.[117] The forge at Makeney, which Mather had tried unsuccessfully to sell in 1777, was similarly taken over by the Strutts, probably in 1780, and a cotton mill built there.[118] At Wingerworth, Mather's accounts end in 1777 and the furnace may have stood idle until the lease of 1781, which led to the building of a coke-fired furnace on a new site but without a forge. According to both Farey and a newspaper advertisement announcing the sale of the works in 1784, the charcoal-fired furnace remained in use until the latter date. Matthews and Butler evidently retained the older process until the success of the new works was established.[119]

The key to all these changes, which marked the end of the traditional iron industry in Derbyshire and Nottinghamshire, was Mather's acquisition of the Staveley lease and his rebuilding of the works on modern lines. Since he had, by this date, secured control of all the other surviving charcoal-fired furnaces in the region, and their associated forges and mills (with the exception of Hurt's works at Alderwasley and Morley Park, which made the transition to coke independently), it was Mather's move to Staveley which both ended the career of the last charcoal ironmaster in the region and marked his own shift to the new technique. Ultimately, therefore, the final demise of the traditional iron industry in the East Midlands was a result of the actions of one landlord and one ironmaster.

As in other parts of the country, the transition to coke-fired smelting in the East Midlands iron industry was a gradual affair, the outcome partly of general trends and partly of local factors. It certainly cannot be explained merely in terms of the price of cordwood, either in the 1750s or later. Individual works were affected by the increasing domination of the market by coke-smelted pig, but at the same time canal building or simply the expiry of a lease might determine the exact date of closure or rebuilding of a particular furnace. Not only does each region have its own history but so does each works and its tenant. By looking at the ironmasters of the eighteenth century as individuals, as well as considering the industry as a whole, the complex reasons for the adoption of coke-fired smelting may ultimately become clear.

## NOTES AND REFERENCES

1. H.R. Schubert, *History of the British iron and steel industry from c. 450BC to AD1775* (1957).
2. As first suggested by M.W. Flinn, 'Revisions in economic history. XVII. The growth of the English iron industry, 1660-1760', *Economic History Review*, 2nd series, XI (1958-9), 144-53. See also P. Riden, 'The output of the British iron industry before 1870', *Econ. Hist. Rev.*, 2nd series, XXX (1977), 442-59.
3. G. Hammersley, 'The charcoal iron industry and its fuel 1540-1750', *Econ. Hist. Rev.*, 2nd series, XXVI (1973), 593-612.

4. This debate has been reviewed in J.R. Harris, *The British iron industry 1700-1850* (1988), which includes full references to earlier work. An important recent contribution to the discussion is L. Ince, 'The introduction of coke iron at the Stour forges of the Knight family', *Historical Metallurgy*, 24 (1991), 107-113.
5. G. Hammersley, 'Did it fall or was it pushed? The Foleys and the end of the charcoal iron industry in the eighteenth century', in T.C. Smout (ed.), *The search for wealth and stability. Essays in economic and social history presented to M.W. Flinn* (1979), 67-90.
6. B.L.C. Johnson, 'The charcoal iron industry in the Midlands, 1690-1720' (Unpublished University of Birmingham M.A. thesis, 1950), and the two main articles based thereon: 'The Foley partnerships: the iron industry at the end of the charcoal era', *Econ. Hist. Rev*, 2nd series, IV (1951-2), 332-40; 'The charcoal iron industry in the early eighteenth century', *Geographical Journal*, 117 (1951), 167-77.
7. For which see A. Raistrick, 'The south Yorkshire iron industry, 1698-1756', *Transactions of the Newcomen Society*, 19 (1938), 51-86; idem and E. Allen, 'The south Yorkshire ironmasters (1690-1750)', *Econ. Hist. Rev.*, 9 (1939), 168-85.
8. See C.C. Owen, *The development of industry in Burton upon Trent* (Chichester, 1978), ch. 6.
9. As best illustrated by G.R. Sitwell, 'A picture of the iron trade (in the seventeenth century)', *Derbyshire Archaeological Journal*, 10 (1888), 28-46; other early studies of less permanent value include G.C. Bond, 'History of early coal and ironstone mining in Nottinghamshire', *Trans. Inst. Mining Engineers*, 67 (1923-4), and W.L. Coleman, 'Some notes concerning Staveley iron works', *Notts & Derbys Notes & Queries* (Nov. 1894).
10. G.G. Hopkinson, 'The development of lead mining, and of the coal and iron industries of north Derbyshire and south Yorkshire' (Unpublished University of Sheffield Ph.D. thesis, 1958). The chapter on charcoal ironmaking was printed virtually unaltered as 'The charcoal iron industry of the Sheffield region, 1500-1775', *Trans. Hunter Archaeological Society*, 8 (1961), 122-51. In both places the author places footnotes at the ends of paragraphs which prove to support only the last of several statements made in each paragraph.
11. E.g. Hammersley, 'Did it fall', p. 85.
12. See Harris, *British iron industry*, pp. 30-37 and the work by C.K. Hyde cited there.
13. Hopkinson did not make use of the small amount of Derbyshire and Notts. material in the Foley MSS at the Herefordshire Record Office and was writing before the establishment of the Derbyshire Record Office, which now houses (in addition to many minor items relating to the early iron industry), the papers from Renishaw used by Sir George Sitwell for the article cited in n.9. The Notts. Record Office has also since acquired material relating to the Mather family in south Derbyshire (below, n.82). For a review of recent work on the coke period see P. Riden, *The Butterley Company 1790-1830* (Derbyshire Record Society, 16, 1990), pp. ix-x.
14. See the articles in the Victoria County History on 'Iron' in *Derbyshire* (II, 1907, 365-8) and 'Mining' in *Leicestershire* (III, 1955, 30-32).
15. J. Farey, *A general view of the agriculture and minerals of Derbyshire*, I (1811), p.396.
16. An analysis of K. Cameron, *The place-names of Derbyshire* (English Place-Name Society, 27-29, 1959), reveals names such as 'Smithy', 'Cinderhill' etc in the following parishes: Alfreton, Barlborough, Barlow, Calow, Chesterfield, Dore, Dronfield, Eckington, Elmton, Heath, Holmesfield, Killamarsh, Morton, Newbold, Pilsley, Staveley, Sutton cum Duckmanton, Unstone, Walton, Whittington and Woodthorpe (Scarsdale Hundred, mostly in the Rother valley); Codnor & Loscoe, Crich, Dale Abbey, Denby, Elvaston, Heanor, Kilburn, Morley, Pentrich and Smalley (Morleston & Litchurch Hundred, the southern half of the coalfield); Matlock Bath and Tansley (Wirksworth Hundred in mid-Derbyshire); Alderwasley, Ashleyhay, Belper, Chaddesden, Duffield, Hazelwood, Heage, Holbrook, Mercaston, Milford, Norbury & Roston, Shirley, Snelston, Spondon, Sudbury and Windley (Appletree Hundred, lower Derwent valley); and Croxall, Melbourne and Netherseal (Repton & Gresley Hundred in the Trent valley).
17. Cf. D.G. Edwards, *The Hunlokes of Wingerworth Hall* (Wingerworth, 1976), pp. 14-15 for ironmaking in this parish.
18. J.M. Bestall and D.V. Fowkes (ed.) *Chesterfield wills and inventories, 1521-1603* (Derbyshire Record Society, 1, 1977); cf. D.G. Hey's introduction, pp. xxvi-xxvii. For the later material (which is being prepared for publication by the Derbyshire Record Society) see P. Riden *Tudor and Stuart Chesterfield* (Chesterfield Borough Council, 1984), pp. 148-58.

19. For an attempt to do this in a region where bloomeries survived later than in the East Midlands see C.B. Phillips, 'The Cumbrian iron industry in the seventeenth century', in W.H. Chaloner and B.M. Ratcliffe (ed.), *Trade and transport. Essays in economic history in honour of T.S. Willan* (Manchester, 1977), 1-34.
20. Riden, *Tudor and Stuart Chesterfield*, p.150.
21. See generally Schubert, *History*, ch. 10-12; for the Weald see H. Cleere and D. Crossley, *The iron industry of the Weald* (Leicester, 1985), ch.6.
22. Hammersley, 'Charcoal iron industry and its fuel', pp.603-6; Riden, 'Output', pp.442-9.
23. R.S. Smith, 'Sir Francis Willoughby's ironworks, 1570-1610', *Renaissance and Modern Studies*, 11 (1967), 90-140; M.B. Donald, *Elizabethan monopolies. The history of the Company of Mineral and Battery Works from 1565 to 1604* (1961), pp.150-1, 160-2.
24. Heanor parish register (Derbys. RO, D.1632A/PI 1/1) contains references in 1599 to 'Codnor parke by the furnace' and 'Loskoe furnace', apparently meaning two different places. In entries dated 1599, 1600 and 1602 the Shorter family are said to be of 'Codner parke furnace' or 'the furnace in Codner parke', while in 1611 Henry Satterfield, probably the person described in an administration bond of 1618 (Birmingham Reference Library, 468993) as an ironfounder of Codnor, was living at Loscoe Furnace. The last reference to Codnor Park furnace in the register occurs in 1612 and the last to Loscoe in 1621.
25. See P.P. Burdett, *Map of Derbyshire* (1762-7).
26. Derbys. RO, D.158M/T.24-27 demonstrate that in 1609 Zouch was in possession of the ironworks at Makeney, Hartshay and Loscoe (the Codnor Park furnace is not mentioned). This slightly revises Dr Smith's view, based on the Middleston MSS, that Zouch never regained control of the works.
27. Schubert, *History*, p.388; Hopkinson, 'Charcoal iron industry', p.123.
28. Schubert, *History*, p.376; Hopkinson, 'Charcoal iron industry', pp. 123-4.
29. Lambeth Palace Library, Talbot MSS (formerly at the College of Arms), M, f.563 (10 Feb. 1609), discusses the building of a furnace and the location of coal and ironstone pits at Shirland and Crich (see G.R. Batho (ed.), *A calendar of the Shrewsbury and Talbot papers in Lambeth Palace Library and the College of Arms* (Derbys. Arch. Soc. Record Series, 4, 1971), p.297). Notts. RO, DD4P 46/23 establishes the existence of at least the Toadhole works by about 1620.
30. For the dispute of the 1640s see Notts. RO, DD/SR/211/128 (kindly drawn to my attention by Christopher Charlton). This material appears to be the basis of the references to Crich forge in W.E. Preston, 'Two seventeenth-century rentals', *Yorkshire Archaeological Journal*, 34 (1939), 329-41 (whence Schubert, *History*, p.388, where the page number is wrong), although this is not obvious from Preston's article, which is based entirely on the Pilkington of Chevet MSS now in the Wakefield Metropolitan District Archives. I understand from the archivist at Wakefield, Mr John Goodchild, that this collection contains no references to the Crich or Toadhole sites. For the manorial history of Crich and Shirland see D. and S. Lysons, *Derbyshire* (1817), pp. 90, 254 and G. Turbutt, *A history of Shirland and Higham, Derbyshire* (Shirland, 1977), pp. 23-5. Cf. also the will of William Kirkham, ironfounder of Toadhole Furnace, proved in 1644 (PRO, PROB 11/193/44v). The site is still called Toadhole Furnace; the forge at Crich has not been located. Since it was clearly on the Shrewsbury estate it cannot be identical with the later forge on the opposite bank at Alderwasley, which has a quite separate tenurial history.
31. Farey, *General view*, I.395; Edwards, *Hunlokes of Wingerworth*, pp. 12-15; the deeds were noted in about 1780 by Samuel Pegge (College of Arms, Derbyshire Collections, II.861-2).
32. William Salt Library, Stafford, HM38 marks the furnace; for the forge see P. Kettle, *Sutton Scarsdale's story. Part 1: The Leekes of Sutton* (Ilkeston, 1988), p.35, quoting an unidentified document of 1614. North Wingfield and Pleasley were still operating in tandem in lessees' hands in the 1650s and 1660s: P. Riden (ed.), *George Sitwell's Letterbook, 1662-66* (Derbyshire Record Society, 10, 1985), pp. x-xii.
33. G.G. Hopkinson, 'A Sheffield business partnership, 1750-65', *Trans. Hunter Arch. Soc.*, 7 (1951-7), p.106, quoting a survey of Staveley of that date at Chatsworth; there appears to be no evidence for his statement elsewhere ('Charcoal iron industry', p.124) that the furnace was built about 1610.
34. PRO, C 2/C6/37 (I am much indebted to Peter King for this reference). Ash cannot at present be identified, although there was a dynasty of Chesterfield merchants of this name (see the works cited in n. 18).

35. D. Cranstone, 'The iron industry of the Ashby coalfield', *Leics. Industrial History Soc. Bulletin*, 8 (1985), 27-30, quoting Farey, *General view*, I.396, 401. The reference of 1606 is from PRO C 2/A3/31 (supplied by Mr Cranstone from information in turn supplied by Brian Awty); the lease of 1624 is Leics. RO, Ferrers MSS, 26D 53/514, and is also noted by C.C. Owen, *The Leicestershire and south Derbyshire coalfield, 1200-1900* (Leics. Museums, 1984), p.40.
36. See above, n. 24 for references in Heanor parish register to the Codnor Park and Loscoe sites. Later occupiers at Makeney can be identified from surrenders and admittances in Duffield manor court books (Derbys. RO, D.1404): New Mills was still a forge in 1617 (Vol. 14, pp. 16-17) but had become a scythe-mill by 1625 (Ibid., pp.138-40, 150-1; cf. Vol. 16, p.30 (1643). After the latter date the tenement appears to have been conveyed as freehold.
37. See n. 30.
38. Hopkinson, 'Charcoal iron industry', p.132.
39. See n. 20.
40. For the Zouch works see n.24; for Wingerworth (in addition to the document cited in n.41) see Notts. RO, DD/SR/211/128, which is also the authority for Staveley remaining in the Frechevilles' hands (cf. n. 30).
41. PRO, E 134/1657/East. 4.
42. Hammersley, 'Charcoal iron industry', pp. 603-6.
43. E.W. Hulme, 'Statistical history of the iron trade of England and Wales, 1717-50', *Trans. Newcomen Soc.*, 9 (1928-9), 12-35.
44. Hammersley, 'Charcoal iron industry', pp. 605-6.
45. D.N. Durant and P. Riden (ed.), *The building of Hardwick Hall* (Derbys. Rec. Soc. 4 and 9, 1980, 1984), esp. p. xxv.
46. See D. Kiernan, *The Derbyshire lead industry in the sixteenth century* (Derbys. Rec. Soc., 14, 1989), ch. 7.
47. *George Sitwell's Letterbook*, pp. x-xiii.
48 Schubert, *History*, p.379; Hopkinson, 'Charcoal iron industry', p.124, and idem, 'Sheffield business partnership', p.105.
49. A map of 1684, marking 'A furnis of Toadhole', is noted by H. Nicholas, *Local maps of Derbyshire to 1770. An inventory and introduction* (Derbys. County Library, 1980), No 330, as being in the collection of L.N. Darbyshire, late of Carnfield Hall, Alfreton, and Lea, Derbyshire, who has since died on the Isle of Man. The present whereabouts of his collection are not known. For the list of 1717 see Hulme, 'Statistical history', pp. 21-2; the list of 1787 is in Birmingham Reference Library, Boulton & Watt Collection, Muirhead II; cf. Riden, 'Output', p.446 for a general account of this source. For other references to Toadhole see Turbutt, *History of Shirland and Higham*, pp.63-4, 154. I am indebted to Mr. Turbutt, whose family's once extensive estate in this parish unfortunately did not include the furnace, for help in trying to discover more of this poorly documented site.
50. Stretton last appears in the Scarsdale Surveys of the 1650s (of which an authoritative text is in the press as part of *A seventeenth-century Scarsdale miscellany* (Derbys. Rec. Soc., 19, 1992)); cf. G. Turbutt, 'Court rolls and other papers of the manor of Stretton', *Derbys. Arch. Journal*, 95 (1975), 20-21. North Wingfield is only documented during Sitwell's tenancy in the 1650s and 1660s (n. 32); there appears to be no evidence for Hopkinson's statement ('Charcoal iron industry', p. 132) that the furnace shut as late as 1700. For the site see G. Griffin, 'The home of the Deincourts', *Derbys. Arch. Journal*, 40 (1918), 206.
51. Schumbert, *History*, p.367. R.A. Mott, 'Early ironmaking in the Sheffield region', *Trans. Newcomen Soc.*, 27 (1949-51), 235 reported that ruins of the furnace were still to be seen on Barlow Brook in about 1950, whence F. Nixon, *The industrial archaeology of Derbyshire* (Newton Abbot, 1969), pp.55, 227. They have since been cleared.
52. The Hartshorne furnace is mentioned obliquely in a leasebook of the Stanhopes, Earls of Chesterfield, in 1699 (ex inf. Mrs J. Spavold); see also Owen, *Leicestershire coalfield*, p.177, and C. Glover and P. Riden (ed.), *William Woolley's History of Derbyshire* (Derbys. Record Soc., 6, 1981), p.154, where it is called a forge. The other references, together with the name 'Furnace Pool' at the site, confirm that it was a blast furnace. See J. Spavold (ed.), *At the sign of the Bulls Head. A history of Hartshorne and its enclosure* (S. Derbys. Local History Research Group, 1984).
53. H. Lloyd, *The Quaker Lloyds in the industrial revolution* (1975), p.146.

54. The only eighteenth-century evidence seems to be the list of furnaces cited in n.49. References to surviving remains appear to originate in E. Mammatt, *A collection of geological facts and practical observations, intended to elucidate the formation of the Ashby coal field, in the parish of Ashby de la Zouch and the neighbouring district; being the result of forty years' experience and research* (1834), p.9, whence C. Fox-Strangways, *The geology of the Leicestershire and south Derbyshire coalfield* (Mem. Geol. Survey England & Wales, 1907), p.112; whence *VCH Leics.*, III (1955), p.31; whence D.M. Smith, *The industrial archaeology of the East Midlands (Nottinghamshire, Leicestershire and the adjoining parts of Derbyshire* (Dawlish and London, 1965), p.123. Cf. the comments of Cranstone, 'Iron industry of the Ashby coalfield', pp. 28-30.
55. Hulme, 'Statistical history', pp.21-2; Riden, 'Output', p.445; Hammersley, 'Charcoal iron industry', p.602. For a new attempt to estimate the number of furnaces in use see P. Riden, *A gazetteer of charcoal-fired blast furnaces in use in Great Britain since 1660* (Cardiff, 1987).
56. Derbys. RO, D.2690, loose sheet enclosed in lease of 1751.
57. Barlow: Hopkinson, 'Charcoal iron industry', p.132; Stretton: see n. 50.
58. Edwards, *Hunlokes of Wingerworth*, p.15.
59. See *George Sitwell's Letterbook*, pp. x-xii.
60. R. Johnson, '17th century iron works at Bulwell and Kirkby, *Trans. Thoroton Soc. Notts.*, 64 (1960), 44; S.D. Chapman, *Stanton and Staveley. A business history* (Cambridge, 1981), p.15.
61. D. Holland, *Bawtry and the river Idle trade* (Doncaster Museum, 1976) remains a useful general study; See also Kiernan, *Derbyshire lead industry*, ch.7.
62. See notes 36 and 76.
63. Lloyd, *Quaker Lloyds*, pp.146-8; 'The early Leicestershire coalfield (1204-1832)', *Colliery Guardian*, 84 (1902), 1121 (I am indebted to Mrs Spavold for the latter reference).
64. *Woolley's History of Derbyshire*, pp.112-13; Burdett's *Map of Derbyshire*.
65. For the general history of the slitting mill see Schubert, *History*, pp.403-11; for Renishaw see *George Sitwell's Letterbook*, pp. xii-xiv, and Hopkinson, 'Charcoal iron industry', pp.135-6.
66. The evidence for mills at these sites is the detailed list of ironworks in Birmingham Reference Library, Boulton & Watt Collection, Muirhead II, compiled in 1794, for which see Riden, 'Output', pp.445-7.
67. Derbys. RO, D.518M/E.95.
68. R. Simpson, *A collection of fragments illustrative of the history and antiquities of Derby* (Derby, 1826), p. 773.
69. Notts. RO, DD/M/119/3-6.
70. See generally R.W. Unwin, 'Trade and transport in the Humber, Ouse and Trent basins, 1660-1760' (Unpublished University of Hull Ph.D. thesis, 1971) and A.C. Wood, 'The history of trade and transport on the river Trent', *Trans. Thoroton Soc. Notts.*, 54 (1950), 1-44. For imports into Hull see G. Jackson, *Hull in the eighteenth century. A study in economic and social history* (Oxford, 1972), pp. 27-41.
71. Chapman, *Stanton and Staveley*, p.15.
72. R.A. Pelham, 'The water-power crisis in Birmingham in the eighteenth century', *University of Birmingham Historical Journal*, 9 (1963-4), 64-91.
73. The introductory matter in *George Sitwell's Letterbook* supersedes Sitwell, 'A picture of the iron trade' as a general account of the family's involvement in the industry.
74. Kiernan, *Derbyshire lead industry*, pp. 229-39.
75. See *George Sitwell's Letterbook* for Clayton; the Herefordshire RO material cited in the next note refers explicitly to the Foley group taking over the Rother valley works from the Sitwells in the 1690s.
76 Herefordshire RO, Foley MSS, F/VI/MBf/1-6 and F/VI/MCf/1-4; for Jennens see Derby Local Studies Library, Kerry MSS, XVII.330-4, and Johnson, 'The Foley partnerships', pp.330-1; the same article describes the Foleys' own holdings in the region on pp. 326-30. See also *VCH Warwickshire*, VII (1964), p.83 for the Jennenses, and *VCH Worcs.*, III (1913), p.219 for the Wheelers. For leases to these groups see Notts. RO, DDP 5/76, 5/78/ 7/22-23, 15/61 and 43/76. For Wingerworth in this period, known still to have been in hand in the 1650s (note 41), see Derbys RO, D.2690, assignment of 1681 and leases of 1681 and 1702. For the Pembertons see Lloyd, *Quaker Lloyds*, passim. For Jennens at Hartshorne see n. 52.
77. Johnson, 'The Foley partnerships', p.336.

78. *Journals of the House of Commons*, XI.410; cf. Unwin, Thesis, pp.170ff and 234ff for efforts to improve this tributary of the Trent.
79. Hopkinson, 'Charcoal iron industry', pp. 134-6 and works cited in n. 7. Original documents relating to this group in the early eighteenth century are now in Sheffield Record Office, Sp.St. 60472-60495 and elsewhere in this collection.
80. Derbys. RO, D.2690, leases of 1717 and 1725, which appear to refute Hopkinson's statement ('Charcoal iron industry', p. 144) that Wingerworth was operated by the Heyford family in this period.
81. Barlow is not heard of after the lease of 1693 (Derby Local Studies Library, Kerry MSS, XVII.330-34) and does not appear in Fuller's list of furnaces of 1717 (Hulme, 'Statistical history', pp. 21-2).
82. Chapman, *Chapman and Staveley*, pp. 12-15; for the Mathers generally see Notts. RO, DD/M/97 and for Borrowash DD/M/119/3-7. At Wingerworth the family were apparently associated with a Birmingham firm, John Mander & Co., from 1741, and in 1758 James Hunloke, the landlord's brother, became a partner there with Mather: Derbys. RO, D.2690, leases of 1741, 1751 and 1758. Kirkby was in Fell's hands in the period 1750-65, although not in blast (Hopkinson, 'Sheffield business partnership', p.105), but in the list of charcoal furnaces closed between 1750 and 1787 (Birmingham Reference Library, Boulton & Watt Collection, Muirhead II), Mather is named as tenant, as he is at 'Hawthorn' furnace, which is presumably Hartshorne.
83. Lloyd, *Quaker Lloyds*, p.147.
84. Riden, *Gazetteer*, pp. 1-7.
85. Riden, 'Output', p. 448.
86. Birmingham Reference Library, Boulton & Watt Collection, Muirhead II.
87. Lloyd, *Quaker Lloyds*, p. 176. The bellows from Melbourne were taken to Wingerworth furnace in May 1773, presumably to be re-used there (Sheffield Record Office, SIR 30).
88 Hopkinson, 'Sheffield business partnership', p.105, confirming from record evidence the date of 1770 given by Farey, *General view*, I.395.
89. D. Cranstone, *The Moira furnace. A Napoleonic blast furnace in Leicestershire* (N.W. Leics. District Council, 1985).
90. P. Riden, 'The ironworks at Alderwasley and Morley Park', *Derbys. Arch. Journal*, 108 (1988), 78-82; see also a 'Postscript' to the main article in Vol. 109 (1989), 175-9, which includes a photograph of the Alderwasley furnace before its demolition.
91. Riden, *Gazetteer*, p. 41.
92. Riden, 'Alderwasley and Morley Park', pp. 82-3.
93. See note 113.
94. G.G. Hopkinson, 'Staveley forge, 1762-83', *Trans. Hunter Arch. Soc.*, 7 (1951-7), 94-5; Chapman, *Stanton and Staveley*, pp. 15-20.
95. Hopkinson, 'Charcoal iron industry', p. 136; idem, 'Sheffield business partnership', 103-17; Chapman, *Stanton and Staveley*, p.17.
96. The Wingerworth accounts are Sheffield Record Office, SIR 30, a volume which has been used on three separate occasions: as a furnace ledger in the 1770s, as a furnace cashbook in the 1790s, and as a furnace order book c.1810. Internal evidence indicates that the earliest accounts are for Wingerworth.
97. See P. Riden, 'Joseph Butler, coal and iron master, 1763-1837', *Derbys. Arch. Journal*, 104 (1984), 87-95 for the transition to coke at Wingerworth.
98. Cuckney: S.D. Chapman, *The early factory masters. The transition to the factory system in the Midlands textile industry* (Newton Abbot, 1969), p.147, and idem, 'The pioneers of worsted spinning by power', *Business History*, 7 (1965), 102-3. Pleasley: Chapman, *Early factory masters*, p.147, and F. Nixon, *The industrial archaeology of Derbyshire* (Newton Abbot, 1969), p.193. Wilne, Chapman, *Early factory masters*, pp. 97, 147, and cf. Derbys. RO, D.664/T.17, 23 and 24.
99. I.e. Burdett's *Map of Derbyshire* of 1762-7.
100. Riden, 'Alderwasley and Morley Park'.
101. Harris, *British iron industry*, pp.30-37, reviews this controversy. My own preference for a definite advance at Coalbrookdale around 1750 (for which see P.J. Riden, 'The growth of the British iron industry, 1700-1870' (Unpublished Oxford M.Litt, thesis, 1978), pp. 138-50) appears recently to

have been vindicated by new evidence from the records of the Knights' enterprises in the Stour valley (L. Ince, 'The introduction of coke iron').

102. Riden, 'Output', p.448 for output statistics during the transitional period; idem, *Gazetteer*, for details of late survivors among the charcoal-fired furnaces.
103. Hopkinson, 'Sheffield business partnership', pp.112 (contracting markets), 109-10 (attempts to use coke) and 117 (final closure); cf. Raistrick and Allen, 'The south Yorkshire ironmasters', p.177. The ledgers and journals used by Hopkinson are now Sheffield Record Office, SIR 26-29.
104. For a review of the transition to coke in the refining branch, with references to earlier work, see Harris, *British iron industry*, pp. 37-40; cf. also Riden, Thesis, pp. 159-74. For forges which had adopted potting by 1794 see the list of ironworks of that date in the Boulton & Watt Collection (note 86).
105. Sheffield Record Office, SIR 29.
106. Sheffield RO, SIR 30 (cf. note 96); Derbys. RO, D.2690, leases of 1758 and 1781 and loose paper enclosed in lease of 1751.
107. Hammersley, 'Charcoal iron industry', pp.608-10.
108. Derbys. RO, D.2535M/D334; cf. Riden, 'Alderwasley and Morley Park', pp.77-8.
109. A point I have discussed further in 'The ironworks at Alderwasley and Morley Park: a postscript', *Derbys. Arch. Journal*, 109 (1989), 175-9.
110. Riden, Thesis, pp. 130-41, for the transition from charcoal to coke generally; idem, *Gazetteer*, for details of the charcoal furnaces still in use in this period.
111. Riden, 'Output', p.448.
112. C. Hadfield, *The canals of the East Midlands (including part of London)* (Newton Abbot, 1967), pp. 33-4.
113. F.J. Stephens, 'The Barnes of Ashgate: a study of a family of the lesser gentry in north east Derbyshire' (Unpublished University of Nottingham M.Phil. thesis, 1980), pp. 112-15; P. Robinson, *The Smiths of Chesterfield. A history of the Griffin Foundry, Brampton, 1775-1833* (Chesterfield, 1957).
114. Chapman, *Stanton and Staveley*, pp. 26-35; Farey, *General view*, I.397.
115. P. Riden, *The Butterley Company 1790-1830* (Derbys. Record Soc., 16, 1990), pp. 9-13; there is still no connected study of Alfreton Ironworks at Riddings.
116. Chapman, *Stanton and Staveley*, p.16.
117. Chapman, *Early factory masters*, p.147; Smith, *Industrial archaeology of the East Midlands*, pp. 80-9. Chapman, *Stanton and Staveley*, p.18, says that Mather disposed of Borrowash to the Thackers, who built a cotton mill there, apparently about 1784, but he did not include Borrowash among the sites taken over from the iron industry in *Early factory masters*, pp. 147-8. Nixon, *Industrial archaeology of Derbyshire*, p.230, offers no evidence for a date of 1800 for the building of the cotton mill there.
118. The date for the conversion of the Makeney site to a cotton mill is usually given as 1777, when the forge was advertised for sale: R.S. Fitton and A.P. Wadsworth, *The Strutts and the Arkwright 1758-1830. A study of the early factory system* (New ed., 1973), pp. 77-8; Chapman, *Early factory masters*, p.148. This appears to have been abortive, however, since the *Derby Mercury*, 6/13 October 1780, carried a fresh advertisement for the sale of the forge, which was also assessed to land tax (as a forge) that year.
119. Riden, 'Joseph Butler', pp.88-9.